

Adequacy Assessment of Time of Dispatch Rules using Fuzzy TOPSIS Method

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Abstract: Adequacy assessment of the existing Time of Dispatch (TD) rules is an academic primary step to improve the regulation of electronic commerce laws. This study aims to evaluate the ASEAN countries based on the adequacy of their TD rules. We propose an extended Fuzzy Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method for evaluation of ASEAN countries' TD based on experts' judgments. Fuzzy TOPSIS is initially a Multi Criteria Decision Making (MCDM) method. In this study, we extend it to a one criterion group decision making method. A group of academic experts is assigned for the judgment of the adequacy of TD in considering countries. The result shows that Singapore has the maximum adequacy in its TD rule among eight ASEAN countries.

Keywords: Electronic Commerce Law, Fuzzy TOPSIS, Group Decision Making, ASEAN, Time of Dispatch, Evaluation.

1. Introduction

The emergence and advancements of information and communication technology (ICT) have changed the traditional paper based way of commercial transactions into electronic commerce. Nowadays e-commerce plays a significant role in business domain [1]. During the last decades, the unification of international trade laws received a remarkable significance and practical actions by international organizations like UN and states as well [2]. However, due to the extra - border feature of the ICT, and the widespread use of e-commerce, unification of the Electronic Commerce Laws (ECLs) got a serious concern. Hence, the regional organizations like the European Union, adopted the EU Directive on Electronic Commerce in 2000 to unify their e-commerce laws. Unification of e-commerce laws will decrease the legal disharmony among the countries and consequently will minimize the legal conflicts. It will affect the rate of international e-commerce transactions by increasing the traders and consumers' trust.

The Association of Southeast Asian Nations (ASEAN) is one of the first regions in the world, which tried to adopt a unified legal framework for e-commerce through international collaborative projects [3]. However, the analysis of e-commerce laws in ASEAN region shows some inconsistency and silent features. This incompatibility of laws is against the ASEAN initiative to unify commercial rules for the member states in line with regional economic integration. On the other hand, it may hinder the pace and scale of international trade of the ASEAN member states. Therefore, it is essential for the ASEAN countries to unify the context of their ECLs in order to complete the harmonization process.

The Time of Dispatch (TD) rule is a critical factor in

regulation of electronic commerce. Therefore, the unification of TD rules for all ASEAN members can smooth the ECLs' unification process.

Group Decision Making is based on considering the judgments of an expert team in the evaluation and ranking of alternatives. The researchers use group decision making to increase the accuracy of decision results [4-7].

This study aims to evaluate and rank eight ASEAN countries with respect to their current TD rules. Among ten ASEAN countries, Lao PDR lacks any English translation of her Act and Cambodia has provided a draft. Hence, we have excluded these two members. This evaluation can be formulated as a decision making problem that the time of dispatch is the only criterion, the experts are decision makers and eight ASEAN countries are alternatives. The fuzzy TOPSIS method has potential to deal with our problem based on two reasons:

- It is an applicable decision making method in decision makings with discrete environment [8].
- The experts express their opinion through uncertain and imprecise linguistic variables. Fuzzy TOPSIS method by using fuzzy set theory can address the uncertainty of the decision makers.

However, Fuzzy TOPSIS is initially a Multi Criteria Decision Making (MCDM) method [9]. In this study, we convert it to a one criterion group decision making method. The main change of this method is assigning the columns of comparison matrix to decision makers instead of the criteria. An expert team, including five academic experts in ECLs is assigned for judgment of TD in considering countries.

The remainder of this paper is organized as follows. The concept of time of dispatch is provided in section 2. The extended fuzzy TOPSIS method is proposed in section 3. In section 4, the achieved results are shown and discussed. Section 5 concludes the paper.

2. Time of Dispatch

One of the primary steps in formation of e-contracts is sending of the offer by originator through electronic message. Determination of the time when the originator sends an offer to the addressee in the form of a data message is called 'time of dispatch'. TD plays a significant role in the law of electronic commerce. Hence, international instruments like the Model Law on Electronic Commerce 1996 (MLEC) and the United Nations Convention on the Use of Electronic Communications in International Contracts 2005 (UNCUECIC) provided special provisions on the time

of dispatch. The United Nations Commission on International Trade Law (UNCITRAL) proposed the MLEC with a recommendatory feature and later, the UNCUECIC which is binding upon its signatories.

Under Article 15 (1) of the MLEC, “Unless otherwise agreed between the originator and the addressee, the dispatch of a data message occurs when it enters an information system outside the control of the originator or of the person who sent the data message on behalf of the originator”. However, under Article 10 (1) of the UNCUECIC which is subsequent to the MLEC, “The time of dispatch of an electronic communication is the time when it leaves an information system under the control of the originator or of the party who sent it on behalf of the originator or, if the electronic communication has not left an information system under the control of the originator or of the party who sent it on behalf of the originator, the time when the electronic communication is received”.

The UNCUECIC continues with a hypothesis in which the electronic communication does not leave the originator's information system. In this scenario which is not in the MLEC, the time of dispatch and the time of receipt coincide [10].

3. Method

The Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method is basically a Multi-Criteria Decision Making Method (MCDM) that use the calculation of distance for determination of preferences [11]. The TOPSIS method has two criteria for determination of preferences [12]:

1. Calculation of shortest distance from the positive ideal solution (PIS)
2. Calculation of farthest distance from the negative ideal solution (NIS)

3.1 Fuzzification of linguistic variables

Fuzzy set theory is an extension of classical set theory proposed by Prof. Zadeh which utilizes to defuzzify and computerize Linguistic or fuzzy variables [13]. Linguistic variables are variables with linguistic term values. The concept of a linguistic variable is very useful in dealing with situations which are too complex or too ill-defined to be reasonably described in conventional quantitative expressions [9, 13]. A fuzzy set \tilde{F} in a universe of discourse X is characterized by a membership function $\mu_{\tilde{F}}(x)$ that is associated with every element x in X a real number in the interval $[0, 1]$. The function value $\mu_{\tilde{F}}(x)$ is termed the grade of membership of x in \tilde{F} [14].

We use a triangular fuzzy number to fuzzify the linguistic variable terms. A triangular fuzzy number \tilde{f} defines through a trio (h, m, l) . The membership function $\mu_{\tilde{f}}(x)$ is defined.

$$\mu_{\tilde{f}}(x) = \begin{cases} (x-h)/(m-h), & h \leq x \leq m \\ (l-x)/(l-m), & m \leq x \leq l \\ 0, & x < h \\ 0 & x > l \end{cases} \quad (1)$$

Let \tilde{f}_1 and \tilde{f}_2 be two triangular fuzzy numbers that are defined through the trio (h_1, m_1, l_1) and (h_2, m_2, l_2) respectively, then the following equations are used for mathematical operations of fuzzy numbers [14]:

$$\tilde{f}_1 + \tilde{f}_2 = (h_1, m_1, l_1) + (h_2, m_2, l_2) = (h_1 + h_2, m_1 + m_2, l_1 + l_2), \quad (2)$$

$$\tilde{f}_1 - \tilde{f}_2 = (h_1, m_1, l_1) - (h_2, m_2, l_2) = (h_1 - h_2, m_1 - m_2, l_1 - l_2), \quad (3)$$

$$\tilde{f}_1 \times \tilde{f}_2 = (h_1, m_1, l_1) \times (h_2, m_2, l_2) = (h_1 \cdot h_2, m_1 \cdot m_2, l_1 \cdot l_2), \quad (4)$$

$$\tilde{f}_1 / \tilde{f}_2 = (h_1, m_1, l_1) / (h_2, m_2, l_2) = (h_1/l_2, m_1/m_2, l_1/h_2), \quad (5)$$

The multiplication of a crisp number “b” and fuzzy number “ \tilde{f} ” is calculated as:

$$b * \tilde{f} = (b \cdot h, b \cdot m, b \cdot l). \quad (6)$$

Also, the vertex method is defined to calculate the distance between two fuzzy numbers \tilde{f}_1, \tilde{f}_2 [14].

$$d(\tilde{f}_1, \tilde{f}_2) = \sqrt{\frac{1}{3} [(h_1 - h_2)^2 + (m_1 - m_2)^2 + (l_1 - l_2)^2]} \quad (7)$$

We assigned a team of experts to rate the adequacy of TD rules in eight ASEAN states. It is suggested that the experts easily use the linguistic scales shown in table 1 to evaluate the rating of countries with respect to their TD rules. The linguistic variables can be expressed in triangular fuzzy numbers as Tables 1. A seven point linguistic scales is adapted from Chen [15]. The fuzzification of linguistic variables in preferences matrix is based on the following table.

Table1. Seven point linguistic scales	
Linguistic variables	Related TFN
Excellent (EX)	(0.9, 1, 1)
Very good (VG)	(0.7, 0.9, 1)
Fairly good (FG)	(0.5, 0.7, 0.9)
Good (GD)	(0.3, 0.5, 0.7)
Preferred (PF)	(0.1, 0.3, 0.5)
Not bad (NB)	(0, 0.1, 0.3)
Poor (PO)	(0, 0, 1)

3.2 Multiple Criteria Decision Making using Fuzzy TOPSIS

When multiple *criteria* should be considered in an evaluation of alternatives, the Fuzzy TOPSIS method constructs a P matrix (Fig 1), preferences matrix, with a set of alternative performing of $A = [A_j]_J$ with regard to criteria $C = [C_i]_n$ as:

$$P = [\tilde{p}_{ij}]_{n \times J} \quad i = 1, 2, \dots, n, \quad j = 1, 2, \dots, J. \quad (8)$$

		Criteria		
Alternatives	P	C_1	...	C_n
	A_1	\tilde{p}_{11}	...	\tilde{p}_{1n}
	\vdots	\vdots		\vdots
	A_J	\tilde{p}_{J1}	...	\tilde{p}_{Jn}

Figure 1. The preferences matrix P of Fuzzy TOPSIS

In Fuzzy TOPSIS, the first step is constructing P matrix. Because of fuzzy numbers, there is no need for normalization of P matrix. If the criteria have different weights, then the weight of criteria should be multiplied in corresponding columns. Then the best fuzzy numbers in the rows of P matrix construct the ideal solution and the worst numbers construct the negative ideal solution. The best fuzzy number is the minimum number for cost criteria and the maximum number for benefit criteria. Also, the worst fuzzy number is the minimum number for benefit criteria and the maximum number for cost criteria. Finally, the Fuzzy TOPSIS method calculates the similarity of alternatives with PIS and NIS by measuring the distance of each alternative from PIS and NIS.

3.3 Group Decision Making using Fuzzy TOPSIS

In this study, we evaluate the ASEAN countries in their current time of dispatch rules and based on experts' judgment. It can be formulated as a decision making problem that the time of dispatch is the only criterion, the experts are decision makers and the eight ASEAN countries are alternatives. Fuzzy TOPSIS is initially a MCDM method. In this study, we convert it to a one criterion Group decision making method. So, we customize the Fuzzy TOPSIS method for decision making with the following attributes:

- One criterion,
- Multi decision makers,
- Multi alternatives.

The proposed customized Fuzzy TOPSIS includes the following steps:

Step 1: Construct matrix P (Fig 2), with n columns and J rows where there are n decision makers and J

alternatives as:

$$P = [\tilde{p}_{ij}]_{n \times J} \quad i = 1, 2, \dots, n, \quad j = 1, 2, \dots, J. \quad (9)$$

Where, $D = [D_i]_n$ is a group of decision makers that judge the $A = [A_j]_J$ as a set alternatives.

The elements of P, are the fuzzy linguistic performance rating (\tilde{p}_{ij}) of "alternative i" in view point of "decision maker j". They are defuzzified TFNs so, the matrix is a normalized.

		Decision makers		
Alternatives	P	D_1	...	D_n
	A_1	\tilde{p}_{11}	...	\tilde{p}_{1n}
	\vdots	\vdots		\vdots
	A_J	\tilde{p}_{J1}	...	\tilde{p}_{Jn}

Figure 2. The preferences matrix P of customized Fuzzy TOPSIS

Step 2: If the experts have different weight, then effect the weights of decision makers on P. The weighted normalized value \tilde{E}_{ij} calculated by $\tilde{E}_{ij} = \tilde{p}_{ij} * wd_i$ where, wd_i is the weight of D_i , $i = 1, 2, \dots, n$ and $n =$ number of decision makers.

Step 3: Identify positive-ideal (S^*) and negative ideal (S^-) solutions using following equations:

$$\text{Positive ideal solution } (S^*) = [\tilde{E}_i^*]_n = [\max E_i]_n \quad (10)$$

$$\text{Negative ideal solution } (S^-) = [\tilde{E}_i^-]_n = [\min E_i]_n \quad (11)$$

Step 4: Measure the distance of each alternative from S^* and S^- using these equations:

$$DIS_j^* = \sum_{i=1}^J d(\tilde{E}_{ij}, \tilde{E}_i^*) \quad i = 1, 2, \dots, n, \quad j = 1, 2, \dots, J, \quad (12)$$

$$DIS_j^- = \sum_{i=1}^J d(\tilde{E}_{ij}, \tilde{E}_i^-) \quad i = 1, 2, \dots, n, \quad j = 1, 2, \dots, J. \quad (13)$$

Step 5: Calculate the similarity to ideal solution.

$$SIM_j^- = \frac{DIS_j^-}{DIS_j^* + DIS_j^-} \quad j = 1, 2, \dots, J. \quad (14)$$

Finally we rank the alternatives according to SIM_j^- in descending order. It means that, the alternative which has the maximum distance from negative ideal solution, is the best alternative.

4. Results and Discussion

This study evaluated eight ASEAN member countries as Indonesia, Malaysia, Philippines, Singapore, Thailand, Brunei, Burma (Myanmar) and Vietnam based on their Time of Dispatch rules by the following stages:

1. The evaluation is formulated as a decision making problem with one criterion (time of dispatch), eight alternatives (eight ASEAN countries) and group decision making (five academic expert in electronic commerce law).
2. We prepared table 2 and asked the experts to rate the countries based on following linguistic variables: Excellent (EX), Very good (VG), Fairly good (FG), Good (GD), Preferred (PF), Not bad (NB), Poor (PO).

Table 2. Rating the countries by experts

	Expert A	Expert B	Expert C	Expert D	Expert E
Indonesia	VG	VG	FG	VG	FG
Malaysia	VG	FG	FG	GD	PF
Philippines	VG	FG	FG	GD	GD
Singapore	EX	VG	EX	VG	VG
Thailand	NB	PF	PF	NB	PO
Brunei	VG	FG	FG	GD	GD
Vietnam	EX	VG	VG	VG	VG
Myanmar	NB	PF	PF	NB	PO

3. The preferences matrix is constructed according to equation (9). We converted the linguistic variables (see table 2) to triangular fuzzy numbers that is presented in table 3. This is based on replacing the linguistic variables with their corresponding TFNs determined in table 1.

Table 3. Preferences matrix (P)

	Expert A	Expert B	Expert C	Expert D	Expert E
Indonesia	(0.7, 0.9, 1)	(0.7, 0.9, 1)	(0.5, 0.7, 0.9)	(0.7, 0.9, 1)	(0.5, 0.7, 0.9)
Malaysia	(0.7, 0.9, 1)	(0.5, 0.7, 0.9)	(0.5, 0.7, 0.9)	(0.3, 0.5, 0.7)	(0.1, 0.3, 0.5)

)	0.9)	0.9)	0.7)	0.5)
Philippines	(0.7, 0.9, 1)	(0.5, 0.7, 0.9)	(0.5, 0.7, 0.9)	(0.3, 0.5, 0.7)	(0.3, 0.5, 0.7)
Singapore	(0.9, 1, 1)	(0.7, 0.9, 1)	(0.9, 1, 1)	(0.7, 0.9, 1)	(0.7, 0.9, 1)
Thailand	(0, 0.1, 0.3)	(0.1, 0.3, 0.5)	(0.1, 0.3, 0.5)	(0, 0.1, 0.3)	(0, 0, 1)
Brunei	(0.7, 0.9, 1)	(0.5, 0.7, 0.9)	(0.5, 0.7, 0.9)	(0.3, 0.5, 0.7)	(0.3, 0.5, 0.7)
Vietnam	(0.9, 1, 1)	(0.7, 0.9, 1)	(0.7, 0.9, 1)	(0.7, 0.9, 1)	(0.7, 0.9, 1)
Myanmar	(0, 0.1, 0.3)	(0.1, 0.3, 0.5)	(0.1, 0.3, 0.5)	(0, 0.1, 0.3)	(0, 0, 1)

4. The positive and negative ideal solution is obtained by equation (10) and (11).

$$S^* = [(0.9, 1, 1) \quad (0.7, 0.9, 1) \quad (0.9, 1, 1) \quad (0.7, 0.9, 1) \quad (0.7, 0.9, 1)]$$

$$S^- = [(0, 0.1, 0.3) \quad (0.1, 0.3, 0.5) \quad (0.1, 0.3, 0.5) \quad (0, 0.1, 0.3) \quad (0, 0, 1)]$$

5. The distance of each country from S^* and S^- is calculated by equations (7), (12) and (13).
6. The similarity of the distance of each country from PIS and NIS is measured using equation (14). The results are illustrated in table 4. The ranks of countries are determined according obtained number of similarities.

Table 4. Rank of countries in adequacy of their TD

Country	SIM_j^-	Rank
Singapore	1.000	1
Viet Nam	1.000	1
Indonesia	0.826	2
Philippines	0.638	3
Brunei	0.638	3
Malaysia	0.317	4
Thailand	0.194	5
Myanmar	0.194	5

When we look at the results, we can see that Singapore and Vietnam both have the highest rank by $SIM_j^- = 1$. The obtained DIS_j^* for Singapore and Vietnam is 0 as they are equal to positive ideal solution. Thailand and Myanmar

obtained the lowest rank with $SIM_j^- = 0.194$. Also, Philippines and Brunei have the same rank since they have a high similarity in their written TD rules.

The analysis of TD rules in the MLEC and the UNCUECIC clears that in 1996, the drafters affected by the current technologies like Electronic Data Interchange (EDI) and in 2005, the tried to be more adaptive with new technologies like internet [16]. Furthermore, the TD rule under Article 10 (1) is similar to the rule in ordinary contracts [10]. Under the MLEC, the time of dispatch is when the data message enters the information system which is not under the control of the originator. However, the convention provides that the time of dispatch is the time when electronic communication leaves the originators' information system.

The majority of ASEAN countries in drafting their electronic commerce Acts, followed the MLEC provisions. In case of TD rules also they adopted the principle of Article 15 (1) of the MLEC. However, they have some differences in the context of TD provisions which considered by experts and resulted in different ranking. With regard to Singapore and Vietnam, they followed Article 10 (1) of the UNCUECIC and considered the time when electronic communication leaves the originators' information system as TD rule. This is the main reason to obtain the first place among all ASEAN members.

5. Conclusion

In this study, we presented an extended Fuzzy TOPSIS method, by considering one criterion, multiple decision makers and alternatives. We employed fuzzy set theory for fuzzification of TOPSIS method to deal with uncertain and subjective data and environment.

The proposed method is applicable for group decision making with one criterion. The ASEAN countries have evaluated in adequacy of TD rule by the proposed method. From the obtained results we conclude that the first strongest countries in TD rule adequacy are Singapore and Vietnam. The Thailand and Myanmar have the lowest rank in comparison with other sis eight countries.

Those states which obtained lower ranks, can modify their TD rules in line with Singapore and Vietnam approaches.

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